MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 2, 2017/2018**

## EOP3036 FABRICATION AND PACKAGING TECHNOLOGY

(OPE)

3 MARCH 2018
2:30 P.M - 4:30 P.M.
(2 Hours)

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**INSTRUCTIONS TO STUDENTS**

1. This question paper consists of 4 pages including cover page with FOUR questions.
2. Attempt **ALL** questions and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

## Question 1

Silicon is a very important semiconductor material which can be used to fabricate photonic devices and its conductivity can be varied by doping.

(a) Explain how silicon ingot is grown by the Czochralski technique.

[8 marks]

(b) Determine the type of silicon wafer that will be resulted if group III material such as boron (B) is doped in silicon. Justify your answer.

[4 marks]

(c) The initial concentration of boron in silicon molten is $2\times10^{19}$ $cm^{-3}$. The segregation coefficient of boron is 0.8.

(i) Calculate the concentration of boron in the silicon ingot after 25% growth.

[3 marks]

(ii) Calculate the resistivity of silicon wafer produced from the silicon ingot when its mobility is measured to be 150 $cm^2V^{-1}s^{-1}$.

[3 marks]

(d) With the aid of a clearly labelled diagram, describe how gallium arsenide (GaAs) epitaxial layer can be grown using the vapour phase epitaxy (VPE) technique.

[2+5=7 marks]

## Question 2

(a) Compare the differences between wet chemical etching and drying etching in the aspects of etching mechanisms and directionality.

[4 marks]

(b) The top view of an array of mesa structure photodiodes and an alignment mark that are fabricated using wet chemical etching on a GaAs substrate is shown in the **Fig. 2(b)**. Draw the top view of the photo-lithography mask required to realise these structures if only **negative** photoresist is available. Label your diagram and the **opaque** regions clearly.

[3 marks]

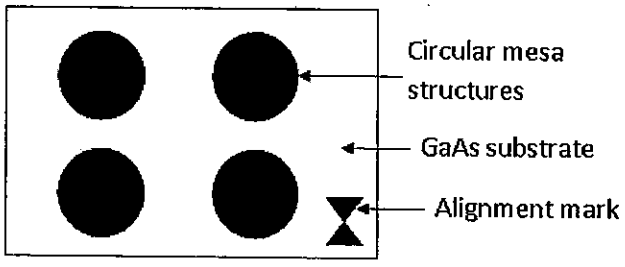


**Fig. 2(b)**

**Continued.....**

(c) **Fig. 2(c)** depicted an indium phosphide (InP) laser diode which consists of an Aurum (Au) bottom contact and an aluminium (Al) top contact deposited on a *p*-InP wafer. With the aid of a series of clearly labelled sketches, design the process flow that would produce the structure in **Fig. 2(c)** and describe briefly every major step involved in the fabrication processes.

[12 marks]

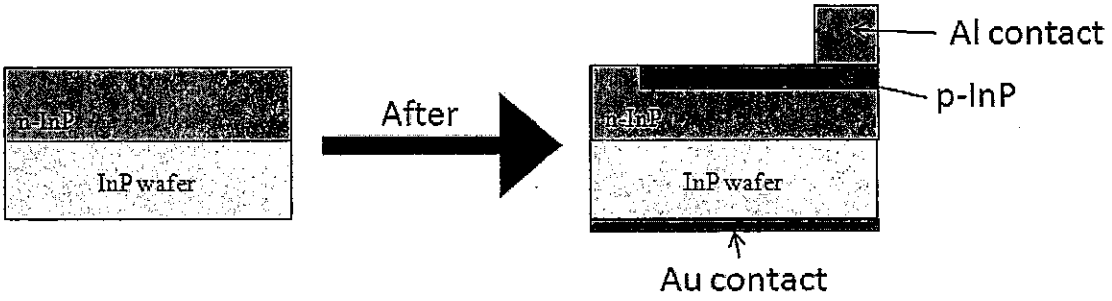


**Fig. 2(c)**

(d) The stability of lasing wavelength of a laser diode depends greatly on the thermal management of the device. With a clearly labelled diagram, discuss how thermal management of a laser diode is designed.

[2+4=6 marks]

**Question 3**

(a) Explain the operation principle of modified chemical vapour deposition (MCVD) which can be used to grow preform for making germanium core silica optical fibre.

[8 marks]

(b) Opticom Fibre Sdn. Bhd. is an optical fibre manufacturer producing various types of fibres for optical communication applications. A client has made an order for a spool of step-index single mode optical fibre. As a R&D Engineer, you are tasked to fabricate the optical fibre using preform method.

(i) With the aid of a clearly labelled diagram, describe how step-index single mode optical fibre is fabricated.

[3+4=7 marks]

(ii) Explain the possible drawbacks of the preform method.

[2 marks]

(iii) The R&D engineer of the company decided to replace the preform method by the Stratified melt method in order to improve the quality of the optical fibres. With the aid of a clearly labelled diagram, describe how the Stratified method can improve the quality of the optical fibre.

[2+6=8 marks]

**Continued.....**

## Question 4

(a) Light propagating along an optical fibre will be attenuated due to microbending losses and affecting the overall performance of the optical fibre.

(i) Discuss how microbending losses are produced.

[7 marks]

(ii) Suggest how microbending losses can be minimised.

[2 marks]

(b) Describe **FOUR** purposes of fibre cabling which is carried out after fibre pulling.

[4×2=8 marks]

(c) **Fig. 4(c)** shows a ribbon fibre cable with multiple loose tube unit cables in the structure. State the name and function of each component labelled as (i), (ii), (iii) and (iv) in the **Fig. 4(c)**.

[4×2=8 marks]

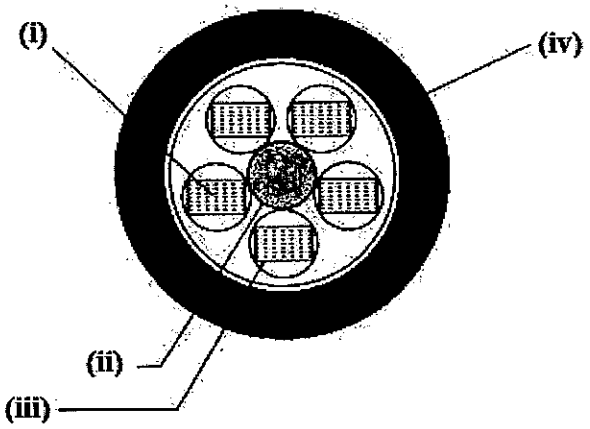


**Fig. 4(c)**

List of constant:-
Electronic charge, $e = 1.6 \times 10^{-19}$ C

**End of Paper**